

Autotransplantation of Teeth with Complete Root Formation: A Case Series

Ji-Hyun Bae, DDS, PhD, ^{*} Yong-Hoon Choi, DDS, MSD, ^{*} Byeong-Hoon Cho, DDS, PhD, ^{*} Young-Kyun Kim, DDS, PhD, [#] and Su-Gwan Kim, DDS, PhD, [#]

Abstract

Introduction: Autotransplantation is a viable option for treating missing teeth when a donor tooth is available. This retrospective study reports the success rate for the autotransplantation of 19 molars with complete root formation. **Methods:** The study enrolled 19 patients (11 men and 8 women) in whom 19 molars were transplanted. The mean age was 38.5 years (range, 19-67). The transplanted third molars were stabilized with a silk suture or wire splint for 2 to 3 weeks. Root canal treatment of the transplanted teeth was performed before surgery in six patients and 1 to 2 weeks after transplantation in 13 patients. Postoperatively, the marginal and periapical conditions were examined clinically and radiographically. **Results:** In 16 of the 19 cases, the outcome met the success criteria, for an 84% success rate. **Conclusions:** In autogenous tooth transplantation, even if the donor tooth has complete root formation, a high success rate can be achieved if the cases are selected and treated properly. (*J Endod* 2010;36:1422-1426)

Key Words

Autotransplantation, complete root formation, success rate

From the Departments of ^{*}Conservative Dentistry and [#]Oral and Maxillofacial Surgery, Section of Dentistry, Seoul National University Bundang Hospital, Seongnam, Republic of Korea; and [#]Department of Oral and Maxillofacial Surgery, School of Dentistry, Chosun University, Gwangju, Republic of Korea.

Address requests for reprints to Dr Su-Gwan Kim, Department of Oral and Maxillofacial Surgery, School of Dentistry, Chosun University, 375, SeoSukDong, DongGu, GwangJu City, South Korea. E-mail address: sgkim@chosun.ac.kr. 0099-2399/\$0 - see front matter

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Autogenous tooth transplantation refers to the repositioning of autogenous teeth in another tooth extraction site or a surgically formed recipient site to replace teeth that are, for example, missing congenitally or involve ectopic eruption, severe caries, periodontal disease, trauma, or endodontic failure when a suitable donor tooth is available (1, 2).

The success rate of autogenous tooth transplantation in the 1950s was approximately 50% because of the difficulty in predicting root development after transplantation and dental root resorption (3, 4). Because too little was known of the causes and prevention of root resorption of transplanted autogenous teeth, the procedure was used infrequently. Since the 1990s, many studies have examined the healing of periodontal tissues and periodontal membrane and dental root resorption, and the transplant success rate increased rapidly, drawing new clinical interest (5-7). Tsukiboshi (5) reported a 90% survival rate and an 82% success rate for 250 cases observed for 6 years. Lundberg and Isaksson (6) reported a 94% success rate in cases with incompletely formed roots and 84% in cases with completely formed roots and a higher success rate in cases with immature teeth, whereas Majare et al (7) reported a high success rate for cases with mature teeth.

Complications of autogenous tooth transplant include root resorption and attachment loss, and its success rate is lower than for implants. Nonetheless, autogenous teeth result in good utilization, the maintenance and regeneration of alveolar bone, and the maintenance of attached gingiva with a natural shape. Hence, the esthetic results are better, the cost is low, one-stage surgery can be used, orthodontic movement is possible, and the procedure can be performed in growing patients (2, 8). Therefore, this retrospective study examined the autotransplantation of mature teeth clinically and radiographically; a case series is reported with a review of the literature.

Material and Methods

This study analyzed the medical records and radiographs of 19 patients (11 men and 8 women) in whom 19 molars with complete root formation were autotransplanted in the Departments of Conservative Dentistry and Oral and Maxillofacial Surgery of Seoul National University Bundang Hospital. The ages of the patients at the time of surgery ranged from 19 to 67 years with a mean age of 38.5 years (Table 1). All of the patients were in good health, and a routine examination found no systemic or local contraindications to surgical treatment.

The reasons for the transplantation were dental caries in seven patients; periodontal disease in three patients; cracked teeth and a request for autogenous tooth transplant after tooth extraction in a dental private office in two patients each; a vertical root fracture, congenitally missing tooth, and endodontic treatment failure in one patient each; and unknown reasons for extraction in two patients. The donor teeth were all third molars, except one patient in which an upper second molar was used. In all cases, the recipient sites were the first or second molar areas (Table 2).

In this study, the criteria for successful transplantation were as follows (1, 2):

1. The transplanted tooth functioned normally without excessive mobility; however, physiologic mobility was allowed. Tooth mobility was classified as grade I: slightly more than normal, grade II: moderately more than normal, and grade III: severe mobility faciolingually and mesiodistally combined with vertical displacement (9).
2. Clinically, no discomfort and a normal periodontal probing.

TABLE 1. Patient Age at the Time of Surgery

Age	Sex	Number
10-19	M	1
	F	1
20-29	M	1
	F	3
30-39	M	3
	F	1
40-49	M	4
	F	2
60-69	M	3
Total		19

M, male; F, female.

3. Radiographically, no root resorption and a normal periodontal ligament space and lamina dura are present.

Surgical Procedure

To prepare the recipient site, when a three-dimensional model of the donor tooth was available, a computer-aided rapid prototyping (CARP) model was used (Fig. 1); otherwise, the transplant site was based on the size measured on radiographs in advance. The recipient socket was prepared with a surgical round bur with copious saline irrigation. Minimizing trauma, the tooth to be transplanted was extracted carefully. To reduce the injury to the periodontal ligament, the tooth was wrapped with gauze wet with saline, an apicoectomy was performed with a diamond point, and the cavity for retrograde filling was formed and filled with mineral trioxide aggregate (MTA) (Fig. 2). To reduce the extraoral time, an endodontic treatment was performed before extracting the tooth to be transplanted if possible. When endodontic treatment could not be performed in advance, it was performed 1 to 2 weeks after transplantation.

The donor tooth was fitted in the prepared transplant site. If additional preparation was required, the additional area was formed using the same method. After tooth transplantation, autogenous bone fragments were placed in the adjacent defect or allogenic bone was grafted. When the transplant site was close to the maxillary sinus, the septal bone was elevated from the maxillary sinus floor using an osteotome and then the tooth was transplanted. When the septal bone was lightly tapped and lifted using a Summers' Osteotome (Implant Innovations, Inc, West Palm Beach, FL), the sinus membrane was elevated, and the space in the recipient site where the donor tooth was grafted was secured (Fig. 3). For early stabilization, the donor tooth was rotated and transplanted in some cases.

The transplanted teeth were fixed with a wire or fiber splint, and any occlusal interference was corrected. When the root was long and early stabilization was good, an over-crown suture was tied over the occlusal surface. The transplanted teeth were splinted for 2 to 3 weeks. The extraoral exposure of the transplanted teeth was from 3 to 16 minutes. Six patients underwent endodontic treatment before transplantation and 13 patients after transplantation. The follow-up ranged from

3 to 21 months and averaged 15 months. Prosthetic treatment was performed 3 to 6 months after transplant.

Results

On radiographs taken immediately after the transplantation, the transplanted tooth was seen in a wide tooth extraction socket. Two weeks after the transplantation, the pain and tenderness had decreased although the tooth mobility was grade 3. One month after the transplantation, the morphology of the transplanted tooth and surrounding gingiva were similar to that of the adjacent teeth. Six months after the transplantation, the mobility of the transplanted tooth had stabilized at grade 1, and the periodontal condition was good. On radiographs, no pathologic radiolucency or tooth resorption was observed. The marginal bone support appeared similar to that of the neighboring teeth. A continuous periodontal space was present radiographically around the transplanted teeth.

Good healing took place when the septal bone was elevated from the maxillary sinus floor, replacement of autogenous bone fragments or transplanted allogenic bone occurred, or the tooth was rotated and grafted. Comparable results were seen in the cases without bone grafting. Prosthetic restoration was performed after 3 to 6 months when the prognosis of the tooth could be predicted. In 16 of the 19 transplanted teeth, no inflammation occurred during the healing period. In addition, no pain, discomfort, or other side effects were noted, and the tooth became stable over time. In the other three cases, severe inflammation and tooth mobility were seen, and the teeth were not fixed within the transplant site; these were considered failures and extracted. In all failed cases, the periodontal condition was poor, and the primary stability of the transplanted tooth was poor. The transplanted teeth met the success criteria in 16 cases for an 84% success rate.

Discussion

To increase the success rate of autogenous tooth transplantation, a healthy periodontal membrane should be present on the transplanted tooth and the root morphology of the tooth to be transplanted should be simple. In addition, infection should be absent in the recipient site, and during surgery, the extraoral period should be short and trauma should be minimized (1, 10, 11). The most important factor for the success of autogenous tooth transplantation is the vitality of the periodontal ligament attached to the transplanted tooth (12). The periodontal ligament is sensitive to pH and osmotic potential, and its viability is reduced if extraoral dry time is long (13). Previous studies showed that the viability of periodontal ligament exposed to the extraoral space decreased rapidly after 18 minutes (12, 14). In our series, the teeth to be transplanted were wrapped with gauze wet with sterile saline during preparation of the recipient site. In all cases, the transplant was performed within 3 to 16 minutes.

If the tooth to be transplanted had reduced root development (ie, an immature root), it increased the probability of pulp healing. In addition, if the tooth was covered with a thick follicle and periodontal

TABLE 2. The Number of Autotransplanted Teeth Distributed According to the Recipient Site

Transplanted tooth	Recipient sites							
	#3	#2	#14	#15	#19	#18	#30	#31
#1	1	5						1
#15					1			
#16				2	1			
#17					1	4		
#32						1		
Sum	1	5	0	2	3	5	0	3



Figure 1. Photographs of a left mandibular third molar extracted for transplantation (left) and a computer-aided rapid prototyping model made of resin (right). (This figure is available in color online at www.aae.org/joe/.)

membrane and was extracted with a weak force, the injury to the root surface was minimized, and replacement resorption rarely occurred. In most cases, the pulp healed and no endodontic treatment was required, shortening the treatment time and the future possibility of developing pulp disease; the risk of root fracture was almost zero. In the cases showing pulp necrosis, the root development ceased and inflammatory root resorption occurred (6, 10).

The pulp of a completely mature tooth cannot regenerate. Therefore, if the tooth to be transplanted is accessible, endodontic treatment should be completed before transplantation. Otherwise, the endodontic treatment should be initiated 1 to 2 weeks after autogenous tooth transplantation. The 1- to 2-week interval is very important because if endodontic treatment is performed too early after autogenous tooth transplantation, additional injury to the periodontal ligament may occur, whereas after 2 weeks, inflammatory resorption may develop from the infected root canal (5).

During autogenous tooth transplantation, extraoral endodontic treatment prolongs the extraoral time, and during manipulation of the instruments, Hertwig's epithelial root sheath of the root cemental surface is injured, increasing the possibility of root resorption (11).



Figure 2. A photograph of MTA retrograde filling. To reduce the injury to the periodontal membrane, the tooth was wrapped in gauze wet with saline. Using a diamond point, an apicoectomy was performed and an MTA retrograde filling performed. (This figure is available in color online at www.aae.org/joe/.)

In this study, in the six patients for whom endodontic treatment was performed before surgery, the transplanted teeth were grabbed with gauze wet with saline, retrograde filling was performed rapidly using MTA, and the tooth was then transplanted; in none of these cases was the extraoral time longer than 18 minutes.

A long time is required to form the bone socket at the recipient site after extracting the tooth to be transplanted by referring to the shape of the extracted tooth. Skilled surgeons could form a recipient site in a short time using techniques similar to implant drilling. However, it may require more than 30 minutes in most cases. When a longer time is required, the period of time that the donor tooth is exposed to the extraoral cavity becomes longer. In addition, while fitting the extracted tooth to the bone socket, the root surface may be injured. In CARP, software is used to produce a shape identical to the real tooth. This was first applied clinically in the 1980s (15). To prepare a model of the donor tooth, three-dimensional data on the tooth to be extracted are obtained (Fig. 1A) and converted into a Digital Imaging and Communications in Medicine format file. Then, a resin or starch model tooth is prepared using computer prototyping (Fig. 1B) (2, 16). When the data are sent to a company specializing in preparing computer-aided rapid prototypes, a model can be prepared in 3 or 4 days. If a CARP model identical to the tooth to be transplanted is prepared before surgery, the bone preparation time is shortened, and injury to the root surface is reduced.

Fong (17) stated that maxillary transplants should not be done because of the extreme variation in the size and shape of the maxillary third molars and because of the proximity of the maxillary antrum to the molar sockets. In our series, however, for the sites adjacent to the maxillary sinus, the septal bone was elevated from the maxillary sinus floor using an osteotome, and for the cases in which the tooth to be transplanted did not fit the recipient site, it was rotated or autogenous bone fragments or allogenic bone was used and good results were obtained. The most important factor in bone formation is the cervical approximation of the transplanted tooth and bone in the recipient area. If the cervical approximation is good, because the bone tissue below the cervical portion is a closed wound and there is a lower chance of infection, there is a tendency to heal well without problems (2). When a maxillary tooth is moved to the mandible because the buccolingual width of the maxillary tooth is wider than the recipient area in the mandible in most cases excessive bone must sometimes be removed. In such cases, if the maxillary tooth is rotated before it is placed, it can be positioned in an anatomically appropriate manner without removing excessive alveolar bone (2).

In autogenous tooth transplantation, long-term firm fixation may have negative effects on healing, whereas nonrigid fixation for 7 to 10 days stimulates the activation of alveolar ligament cells and bone healing (18, 19). Tsukiboshi et al (1) reported that the tooth should be fixed for between 2 weeks and 2 months depending on whether the mobility is reduced. In our series, the fixation was removed after 2 to 3 weeks when any vertical mobility had disappeared.

Following Chamberlin and Goerig (20), tooth transplantation was judged successful if the tooth was fixed in its socket without residual inflammation; masticatory function was satisfactory and without discomfort; the tooth was not mobile; no pathological condition was apparent radiographically; the lamina dura appeared normal radiographically; the tooth showed radiographic evidence of root growth; and the depth of the pocket, gingival contour, and gingival color were all normal. The prognosis of autogenous tooth transplantation depends on the level of root development, the formation of the root apex, the condition of the periodontal ligament of the transplanted tooth, the method of tooth fixation, the match between the transplanted tooth and recipient socket, and the time of endodontic treatment (1, 8,

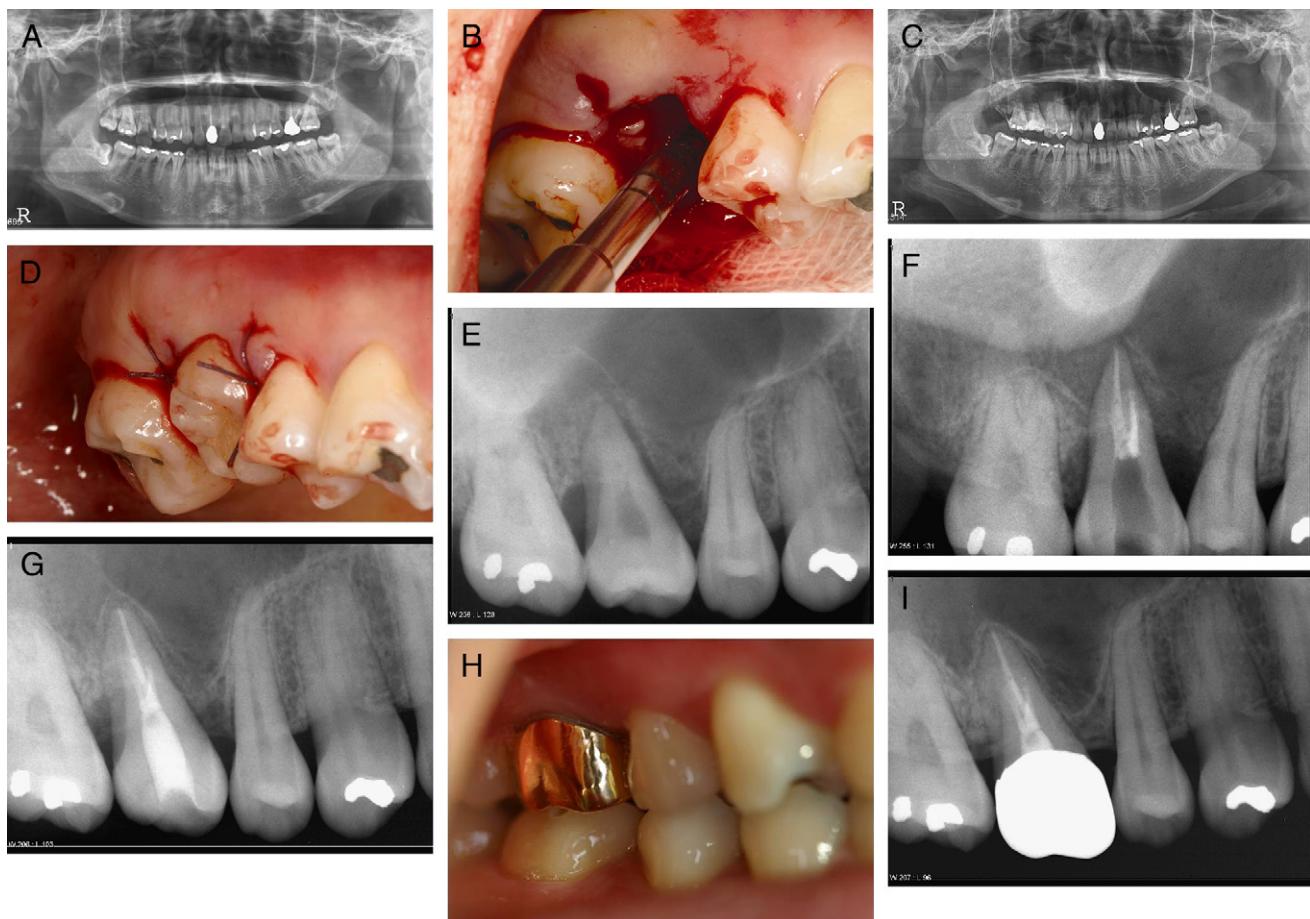


Figure 3. When the transplant site is close to the maxillary sinus, the septal bone in the extraction socket was elevated. (A) A panoramic radiograph of a 25-year-old woman with severe caries of the right maxillary first molar (#3). The tooth could not be restored, and it was decided to transplant the third molar (#1). (B) The septal bone was elevated into the sinus cavity using a Summers osteotome. (C) A panoramic radiograph immediately after transplantation. Because the recipient site was close to the maxillary sinus, the septal bone was elevated from the maxillary sinus floor and the tooth transplanted. (D) A photograph taken immediately after transplant. The #1 tooth was transplanted to the #3 position. (E) An intraoperative radiograph 1 week after transplantation. The septal bone is elevated in the recipient extraction socket. (F) An intraoperative radiograph immediately after endodontic treatment (1 month after transplantation). The features of the root apex of the transplanted tooth and the distal bone regeneration are shown. (G) An intraoperative radiograph 6 months after transplantation. (H) A photograph after prosthesis treatment. (I) An intraoperative radiograph 19 months after transplantation. No inflammation or resorption was detected. The marginal bone support appeared similar to that of the neighboring teeth. A continuous periodontal space was present radiographically around the transplanted teeth. (This figure is available in color online at www.aae.org/joe/.)

10). Transplanted teeth have a poor outcome because of the failure of periodontal reattachment or the occurrence of root resorption in the engrafted cementum-root surface (2, 21). The failure of cementum reattachment may be induced by periodontal inflammation, inflammation in the alveolar socket, or in cases with insufficient early fixation after transplantation. Therefore, transplantation is contraindicated in cases with infection in the root apex. During tooth extraction, chronic inflammatory tissues should be removed completely. In this study, the follow-up period averaged 15 months, which is shorter than in other studies. Nevertheless, 16 of the 19 cases met the success criteria for an 84% success rate. No inflammation or replacement root resorption developed during the follow-up period. This result is comparable to the success rates of autogenous tooth transplantation of teeth with a mature root apex reported by Lundberg and Isaksson (6) and Majare et al (7). In our series, three cases failed. The possible cause of the failure in all cases was the poor periodontal condition caused by the incomplete removal of chronic inflammatory tissues. In one case, early stabilization could not be achieved, and splint fixation was required for 3 months; however, the level of tooth mobility did not decrease, and it was considered a failure and extracted.

Autogenous tooth transplantation is a procedure used in cases when restoration is impossible because of, for example, severe dental caries, root fracture, alveolar problems, or the failure of endodontic treatment. It involves transplanting and fixing another of the patient's teeth. If the cases are selected properly and appropriate surgery and maintenance are performed, the success rate is relatively high, and it contributes greatly to prolonging the function of the natural teeth.

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